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New Air Terminal Douglas Municipal Airport, Charlotte, North Carolina

Michael Patrick Keeshen
Clemson University

NEW AIR TERMINAL

DOUGLAS MUNICIPAL AIRPORT

CHARLOTTE, NORTH CAROLINA

A Comprehensive Project submitted to the Faculty of the College of Architecture, Clemson University in partial fulfillment of the requirements for the Degree, Master of Architecture.

by

Michael Patrick Keeshen

Approved:

[redacted]

Committee Chairman

[redacted]

Major Advisor

[redacted]

Head, Department of Architectural Studies

[redacted]

Dean, College of Architecture

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For my Mother and Father

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AIR TRANSPORTATION FOR

THE CHARLOTTE REGION

Douglas Municipal Airport

The intent of this terminal project is to develop a passenger terminal for Douglas Municipal Airport in Charlotte, North Carolina. The total complex is designed to serve the region as a functional and economical conduit between the land and the air which is compatible with both the human and natural environments. Based upon a proven need, the design process includes development of the air terminal which incorporates three major systems: passenger (transportation to terminal), passenger (transportation inside terminal) and baggage transport.

INTRODUCTION

INTRODUCTION

Air transportation is vital to the contemporary american society making the airport one of the greatest assets of a city. The airport works as a stimulus to the standard of living in terms of economic growth and the services it offers the public. However, when an airport becomes congested and difficult to use, it becomes more of a liability to a city. The airport must enhance its services through planning and good design so they outnumber the intangible costs of critical issues like congestion and noise.

Projections of future demand indicate continued growth in the use of air transportation by people and for goods. Growth at Charlotte is at the point where the critical issue of congestion is beginning. However, the potential is still present for the development of the facilities needed to uniquely prepare the city for the projected growth before it occurs.

One major obstacle in the path of future expansion is the compatibility of existing land use of the surrounding area. The land surrounding the airport consists of residential areas which are not very compatible with the noise associated with the airport environment. At present, the expansion of the runways has been halted by a court order because of this issue. Resolvement of this incompatibility is critical to the growth of the airport.

AIR TRAVEL

AIR TRAVEL

Growth of Air Travel

The exact beginning of man's desire for flight is impossible to determine. Flight has probably been a dream of man from the first time he noticed the birds soaring in the sky. The first recorded example of man's dream can be construed from Greek Mythology in which Daedalous and his son Icarus constructed wings of wax to assist their escape from the Labyrinth of King Minus. Unfortunately, man was to wait nearly 2,000 years before the dream illustrated by the Greeks would be realized.

After waiting so long, development was swift. Today in a world of jumbo jets and supersonic transports, it is difficult to believe powered aircraft were non-existent 75 years ago. Before 1920, there were no air carriers, and as recently as 40 years ago, jet planes were non-existent.

At the outbreak of World War II, the Nation's airlines provided only slightly over one billion passenger miles a year. In 1970, only 30 years later, the total has grown to 125 billion passenger miles, with only 8 billion of the growth occurring by 1950. In the last two decades, air traffic has multiplied 20 fold, creating a growth trend that is expected to continue despite system breaks like the energy crisis of 1973.

The development of the airlines initiated in 1910 in Germany. However, the prototype for the modern air carriers was not established until the 1930's. Commercial airlines began with the development of the Boeing 247, a twin engine plane capable of carrying 10 passengers 485 miles at a speed of 155 mph. Air transportation first took hold of the market and gained substantial support with the invention of the jet engine in 1939. After World War II, because of increased air speeds, reliability and capacities, airlines were established as an important component of mass transport proven essential for communication.

Airport growth paralleled that of the airlines. Many major "hubs" were first developed during the 1930's. They were designed for the all metal DC-2's and DC-3's. Airports and air carriers of this period did well to provide basic transportation. Passenger amenities were a thing of the future. Since World War II the growth has been phenominal. Airports, in general, have had to keep up with the increases in passengers created by technological advances. However, the airports of the 1950's are at best substandard for the 747's of today. The dynamic growth of the industry sees many airports outdated before they are completed. Long range planning is essential. As the aviation industry completes its third-quarter of the century, the airports must plan to meet expected air traffic volume.

National Forecast

The predicted growth of the aviation industry, particularly air carrier activity, is described by the FAA as modest during the next decade compared to the trends of the past decade. However, any growth might seem modest when compared to that of the last 10 years. The major reasons for this slowed growth include energy, rising operating costs, higher plane fares, airport environmental and economic regulations, and the generally depressed economy.

The energy crisis of 1973-74 is a prime example of the pressure facing the industry. During this period shortages forced the rationing of jet fuel which caused air carriers to cut back on their flight numbers. However, as fuel supplies increased, air carriers operations had climbed six percent by December 1974. Yet, despite fewer flights, three percent more passengers were served during the "crisis"!

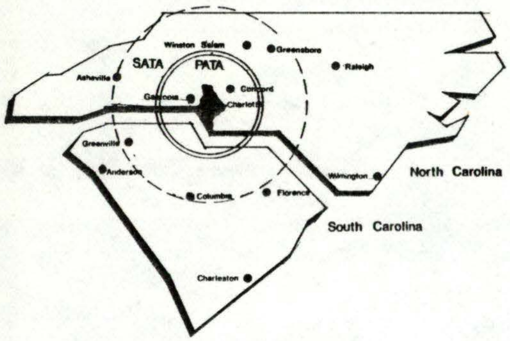
The view ahead, while not as good as the last decade, is certainly indicating growth. The FAA forecasts that the number of passengers served by the airlines will increase by 72 percent over the next 10 years. The effect of this growth, and the even greater growth projected for general aviation activity, will be substantial. Operations at control towers will rise from 56.8 million to possibly 115.9 million by 1985.

The most important factor affecting growth will be the nation's ability to supply airport facilities equipped to handle the expected increases. There must be changes in both manpower and facilities in order to safely and efficiently handle a doubling of the present air traffic volume.

While these forecasts do not reflect some proposed legislation changes which might effect the industry, they are based on the best available data.

AIR TRADE AREA

AIR TRADE AREA



Definition

The air trade area is the term used for the region served by the airport. The area of influence of Douglas Municipal Airport includes two counties and two states and is illustrated in Figure 1. This area is determined by travel time between the airport and existing and potential residences, proximity of competing facilities, and surveys of the origin and destination of passengers. The boundaries define the primary and secondary market areas, however, they do not represent the complete area served.

Historical Review

The Douglas Municipal Airport is located in the Western portion of North Carolina in the city of Charlotte. Charlotte is the largest city in Mecklenburg County. The airport is on a 3,000-acre site located approximately four miles from the central city.

The original airport facilities were constructed under the leadership of Mayor Ben Douglas in the early 1930's. The runway complex was first paved by the N.P.A. during the Roosevelt Era. World War II resulted in the army using the airport as a flight training base. During this period the runways were lengthened and strengthened. Many of the auxiliary facilities which were used by the army still exist on the site as warehouses and commercial shops.

After World War II, the airport was returned to the city of Charlotte. With the exception of the terminal building constructed in the 1950's and the extension of one of the runways, the improvements to the airport were limited primarily to maintenance of the runways and adapting the facilities to meet the needs of aircraft changes. However, a facility designed to accommodate DC-8's of 20 years ago cannot be expected to adapt efficiently to the wider bodied, larger jets that have resulted from increased technology.

The airport is currently being served by five air carriers -- Delta Airlines, Eastern Airlines, Piedmont Aviation, Southern Airways, and United Airlines -- each of which provide both passenger and air cargo services.

Factors Influencing Growth of Air Trade Area

The demand for the airport facilities is a factor of several socio-economic factors of the air trade area. These determinates include:

1. The population of the area of influence, and more importantly, growth in the age segment that is more likely to use the facility.
2. The disposable income.
3. Non-agricultural employment.
4. Geographical factors.
5. Airport traffic data.

Sociological factors, political factors, the competiveness of the industry and the development of unique economical, social, or recreational resources are other factors which also influence growth. Generally these factors are more difficult to project than the others. Yet their input can be staggering to air traffic growth.

The sociological trend towards a more urbanized society with emphasis on increasing mobility are certainly growth signs for air travel. Shorter work weeks resulting in increasing leisure time also determine the general demand for air travel.

The granting of new traffic rights and other governmental actions will also effect the industry. Taxes, fees, and governmental fuel restrictions, like those of the 1973 energy crisis,would have negative effect on growth, as would the possibility of government support of other transportation modes. This type of anti-airline support could influence the ability of the air carrier industry to compete with alternate means of transportation. On the other hand, technological advances in aircraft design can create even greater demands for air services and make the industry more competitive than it already is.

● Population Data: Population forecasts indicate that if current trends continue, the primary air trade area will continue to grow at a rate well above the national average.

Since 1950, the primary air trade population has increased by 71 percent while the U. S. population has grown at a rate of only 34 percent.

This growth trend is in keeping with general trends of the Southeastern "Growth Belt" stretching from Washington, D.C. to Atlanta, GA. along Interstate 85. This area continues to outgrow the nation in terms of population. It is significant to illustrate that the population of the PATA was 409,370 in 1970. This figure accounts for eight percent of the state population. More importantly, the PATA's percentage of the state and regional population continues to increase. In 1900 the population of the area was approximately 50,000 accounting for only three percent of the people in North Carolina.

SELECTED POPULATION STATISTICS

	POPULATION		
	1960	1970	1980
United States	179,323,175	203,211,926	236,725,000
(Growth Rate)	18.5%	13.3%	16.5%
S. Atlantic Region	25,972,000	N.A.	N.A.
South Carolina	2,383,000	2,837,000	3,481,000
North Carolina	4,556,155	5,250,000	6,000,000
Two-State Total	6,939,155	8,087,000	9,481,000
PATA	316,800	409,370	528,708
(Growth Rate)	32.5%	29.2%	29.2%

SELECTED POPULATION AS PERCENT OF U.S.

South Carolina	1.34	1.36	1.44
North Carolina	2.56	2.51	2.49
Two-State Area	3.90	3.87	3.93
Charlotte PATA	0.18	0.20	0.23

Source: Airport Manager's Records

- Employment And Income Data: The non-agricultural employment data depicts Charlotte's role as a regional trade center. The data shows a general increase in employment. The table also indicated a drop from employment in manufacturing as a percent of the entire non-agricultural area, while wholesale/retail trade shows a partial increase.

Income data is available from the airport managers records. These records trace the increase in the numbers of households with $10,000 and more. This measurement of disposable income is a key indication realistic to the demand of air services. The data indicates that the primary air trade area is above the national average in this trend.

- Geographical Data: The air trade area climate is generally temperate. The average temperature of the hottest month, July, is 78.9 degrees. Fog occurs several times during the winter months, but dissipates in a short period of time. The maximum frost penetration is about five to six inches.

The average annual precipitation is approximately 47 inches. This is evenly distributed throughout the year with the maximum occurring in July and August.

The geographic distribution and distances between the population and commerce both indicate a density favorable to supporting air transportation.

The physical characteristics propose few restrictions on air trade.

The general topography is that of rolling hills in the middle of the "Piedmont Belt." The area contains low, rounded ridges which generally slope to the creeks and rivers. The average elevation at the airport is 720 feet above sea level with the highest elevation being 748 feet above sea level.

The physical and climatic attractions indicate the attractiveness of Charlotte as a place to live which may reflect the growth trend in population for the area.

- Summary: In essence, historical activity indicates that the primary trade area is continuing to grow in numbers and influence at a rate well above that of the nation as a whole. This data indicates continued growth for the airport and significant demand for air transportation services and facilities.

AIR ACTIVITY HISTORICALLY

● Passenger Activity: In the recent past, passenger activity at Charlotte has continued to grow. With few exceptions, each year these growth rates have exceeded the national average. The result is Charlotte accounting for .55 percent of the Nation's total in 1971.

This places the airport in the "medium hub" category -- airports whose total enplanements account for between .2 and .99 percent of the nation's total.

Douglas Municipal Airport has been consistently in the top half of the "medium hub" group. In 1971 there were 37 medium hubs of which Charlotte was ranked fifteenth.

Passenger enplanements for the year 1973 were 9 percent greater than those for 1972. The year 1974 showed an even larger growth trend of 10 percent, as compared to the national average of 6 percent for the same period. This growth rate reinforces optimism for Charlotte's future. Significant to the consistent growth rate above that of the nation's is the fact that in each new month a new passenger enplanement record is established at Charlotte.

Breaking the passengers into air carrier groups, we see Eastern Airlines accounting for 70 percent of the total. Delta Airlines and Piedmont Aviation share over 7.5 percent, leaving 5.5 percent of the passengers shared between United Airlines and Southern Airways.

HISTORICAL ENPLANED PASSENGERS

Year	Passengers Enplaned Scheduled Service	Percent Change CLT	Percent Change U.S.	As a % of U.S.
1962	343,297	--	--	.58
1963	402,850	+ 17.3	+ 14.3	.60
1964	489,065	+ 21.4	+ 13.9	.63
1965	567,177	+ 16.0	+ 16.3	.63
1966	548,273	- 3.3	+ 14.7	.53
1967	628,134	+ 14.6	+ 20.9	.50
1968	731,061	+ 16.4	+ 14.0	.51
1969	806,278	+ 10.3	+ 5.0	.54
1970	844,735	+ 4.8	+ 3.8	.55
1971	860,611	+ 1.9	+ 1.6	.55
1972	1,042,503	+ 21.2	NA	NA
1973	1,115,000			

Source: CAB/FAA, Airport Activity Statistics of Certificated Route Route Air Carriers (1962-1969), Part II, Table 3, Column 9. Airport Management Records (1970-1971). Arnold Thompson Associates

- Air Cargo: Air cargo is a category which includes air freight, air expenses, and mail carried by aircraft. Charlotte is currently ranked number one among 40 medium hub airports in the United States. Air cargo growth trends are similar to those of enplaned passengers, Charlotte's growth rate in air cargo also exceeds the national average.

- Aircraft Operations: Along with the air carriers the airport is also used by the military and also for general aviation. Air carrier operations account for approximately 37 percent of the total airport operation. General aviation has almost doubled their volume in the last decade. About 58 percent of the total operation at Douglas Municipal Airport are general aviation. This figure is recently beginning to decrease reflecting a trend of general aviation to utilize other airports as air carrier activity increases. This is similar to trends at other large airports where general aviation declines when the air carrier operations grow. In as much as the general aviation group consists of mostly flight instruction and pleasure flying; smaller, general aviation airports can more easily be used to accommodate this group.

Military operations account for only five percent of the total. The trend is for these operations to also decline. Most of the military operations are intinerant.

HISTORICAL AIRCRAFT OPERATIONS

Douglas Municipal Airport
Charlotte, North Carolina

Year	Air Carrier	General Aviation	Military	Grand Total
1960	55,291	50,680	19,519	125,490
1961	55,083	55,537	12,865	123,485
1962	47,235	53,686	12,017	112,938
1963	48,686	58,636	10,453	117,775
1964	46,650	64,879	9,750	121,279
1965	44,948	80,677	9,927	135,552
1966	39,760	111,884	7,924	159,568
1967	49,086	115,742	9,855	174,683
1968	57,720	102,698	6,469	166,887
1969	63,515	99,021	6,572	169,108
1970	62,350	93,507	6,926	162,783
1971	61,870	98,247	7,766	167,883
1972	64,904	107,871	9,037	181,812

Source: FAA, Air Traffic Activity for calendar years noted.
Arnold Thompson Associates

FORECASTS

AVIATION DEMAND FORECASTS

General

In order to effectively plan for the needs of the Douglas Municipal Airport, it is necessary to determine the probable demand for air travel facilities. The principle determinant of future requirements is the amount of air carrier activity that will be generated by the air trade area. These forecasts form the basis for planning future facility requirements.

Forecasts need to be short term, intermediate, and long range (5, 10, and 20 years). One must recognize that the long range projections are very approximate in nature.

"Today's airport crisis can be attributed in part to inadequacies of past forecasts." Forecasts have tended to underestimate the demand for aviation and also have been too limited in their scope. On the other hand, many reliable forecasts can and have been made which have not been used or developed through careful planning. Good airport design is dependent upon both reliable forecasts which create proposals to be executed through careful planning: Thus, eliminating the current problems connected with most of our airports today.

Forecasting Methods

The primary determinants for forecasting include consistency with past trends, comparison for forecasts with the actual data, comparison of rates of change, and comparison of the economic indicators.

Ideally, all factors of growth should be studied in depth by obtaining accurate forecasts of each, assigning an appropriate weight, and mathematically calculating a forecast analysis for the trade area. In reality it is beyond the scope of this project to undertake such an indepth analysis. However, past developments and general forecasts for the air trade area are available and have been analyzed along with the historical aviation activity.

Three forecasts have been conducted for the airport, two by outside consultants and one by an air carrier. Of these forecasts, the one done by Arnold Thompson Associates is the most recent and assumed to be the most accurate. Much of the data used in this study reflect that of this independent professional study.

Finally, these forecasts must be viewed as estimates of what can reasonably be expected to occur. However, the effects of the special unpredictable events already pointed out, and those of economic fluctuations are limitations common to any projection, and do not invalidate the forecasts as a guide for long-range planning.

Enplaned Passengers

This forecast indicates the total number of passengers departing an aircraft at Douglas Airport including originations, stopovers, and transfers. Stopover passengers are those who will board a flight in another city which travels through Charlotte before reaching its final destination. Transfer passengers are those also initiated flights at another city but who, while stopping at Charlotte, change flights. This connection can occur within one airline--intraline transfer or between two airlines--interline transfer.

The reasoning for a distinction between the types of enplaned passenger is two fold. One, the factors which influence growth are different for each category and secondly, the facilities will be different for each type. "Transfer passengers do not normally need access to parking, curbside or ticket facilities" while they do use the "amenities, such as concessions, restrooms, waiting lobbies, circulation areas, and departure lounges."

In 1973 originating passengers totaled 775,000. Based upon the air trade data, indications of growth above the nation's data the following projections were established.

Past experience indicates that airports with annual enplaning levels of 800,000 to 100,000,000 will normally have top transfer traffic of approximately 9 percent to 12percent. Charlotte is unique in this respect. Eastern Airlines' current policy shows intraconnecting traffic projected to stabilize at approximately 33 percent of the enplaned traffic. Interline traffic is currently 6 percent of the total and is forecasted to increase to 7 percent based on increasing growth.

ENPLANED PASSENGER FORECAST
(IN 1,000's)

YEAR	ORIGINATING	CONNECTING INTRALINE	CONNECTING INTERLINE	TOTAL ENPLANED
1973	775	279	61	1,115
1975	950	370	80	1,400
1980	1,500	600	150	2,250
1985	2,300	950	250	3,500
1990	3,300	1,420	380	5,100
1995	4,300	1,850	550	6,700

Air Carrier Operations Forecasts

The air carrier operations forecasts are directly related to the total enplaned passenger forecasts. They incorporate the total number of arrivals and departures from the airport. The forecasts reflect anticipated increases in industry technology. The average airplane size will probably increase, as will the load capacity of the planes. Therefore, more passengers can be anticipated on each plane in future years.

The projected growth is consistent with the historical pattern. By 1990 the total operations are expected to more than double as compared with 1971.

Year	Enplaned Passenger	Passenger Per Operation	Air Carrier Operations
1971	860,611	28	61,870
1975	1,400,000	42	66,700
1980	2,250,000	54	83,300
1985	3,500,000	65	107,700
1990	5,200,000	75	139,000

Peak Hour Forecasts

These forecasts yield the number of passengers which can be expected at the airport at one time. Extensive surveys have been conducted and the information is available from the manager's records. These surveys project a marked increase in peak hour enplaned passengers for the next 20 years.

Peak Hour tabulations are necessary for determining the square footage requirements of most of the terminal facilities. In addition, some of the areas, like check-in counters and baggage claim, require a further breakdown of this information into peak hour arriving and departing passengers. The forecasts are illustrated in the following table. Significantly one notices that passenger arrivals are lower, indicating that arriving flights are spread out over a longer period of time than departing flights. This is a condition which is expected to continue.

PEAK HOUR ENPLANING AND DEPLANING PASSENGERS

Year	Total Peak-Hour Passengers	Peak-Hour Enplaning Passengers	Peak-Hour Deplaning Passengers
1971-72	850	580	510
Forecast			
1975	1,250	850	750
1980	1,900	1,300	1,100
1985	2,800	1,900	1,700
1990	3,900	2,700	2,300
1995	5,100	3,600	23,900

GROUNDSIDE FORECASTS

Groundside Travel Demands

It is important to realize that the total vehicular traffic will not necessarily increase in direct proportion to total enplaned passengers. For instance, transfer passengers enplanements do not affect these projections. And other modes of transportation, such as the proposed mass transit link to the CBD, may also effect vehicular traffic in the future regardless of the number of enplaned passengers.

The magnitude of the forecasts makes clear the impact the airport has on the regional ground transportation system. This data comes from a survey which indicates that 71 percent of all the enplaned passengers used vehicles (29 percent were transfers). This totals 100 percent as there is no form of mass transit presently operating to the airport.

Vehicular access to the airport will be expanded with the realization of North Carolina Highway plans to build two belt-ways passing on each side of the airport.

The table illustrates the projected volumes with the addition of these roads. No traffic data is available for the distribution of trips by air cargo, and employees.

Distribution of Trips From the Airport

The passenger data indicates that the airport is a regional facility, as it serves a wide area. It was found that only 13 percent of the air passengers were bound for downtown Charlotte. This trend is in keeping with the trends at other airports of this size. The very wide variety of destinations tends to add more negative support to the initiation of mass transit as an alternate mode of transportation.

Peak Hour Forecasts

Ground transportation to and from the airport generally shows some variation from day to day and week to week, with Thursdays higher than average and weekends below average. In-bound traffic is heaviest in the mornings and early afternoons while out-bound traffic is heaviest in the late evenings. The peak hour design volume is currently 497 vehicles. As the total traffic increases, there should be a decrease in the peak hour as a percent of the total average annual daily traffic.

TERMINAL AREA ENTERING OR EXITING VEHICULAR TRAFFIC

Year	Originating Passengers	Vehicles per Passenger	Average Annual Daily Traffic	"K" Factor	DHV Entering or Exiting
1971-72	673,181	2.094	3,860	12.87	497
Forecast					
1975	950,000	2.07	5,400	12.5	700
1980	1,500,000	2.05	8,400	11.9	1,000
1985	2,300,000	2.03	13,000	11.2	1,500
1990	3,500,000	2.00	19,000	10.5	2,000

FACILITY REQUIREMENTS

AIRSIDE

Aircraft Parking Requirements

The number of aircraft loading/unloading positions required for the air terminal is dependent upon two major factors--the passenger enplanements and the airline flight schedule. Additional factors included exclusive assignments of parking positions, quantity of air carriers, and the length of time positions are used.

Exclusive use of aircraft parking positions is the accepted practice of the airlines today, although this creates a higher requirement for parking spaces. It is anticipated that this practice will continue.

The length of time a position is occupied is dependent upon another forecast. It relates to the size of the aircraft. Therefore, it is essential to reflect technological advances in aircraft design to insure accuracy in the forecasts. Other less important factors which effect the time include the service of the flights including food loading, fueling times and passenger and baggage loading time. Analysis of present conditions reveal 16 gates being used for peak hours and 13 parking positions in use during the off peak hours. Forecasts based on these factors are illustrated in the tables.

AIRCRAFT PARKING POSITIONS

Year	Enplaned Passengers	Enplaned Passengers Per Position	Terminal Parking Positions Required
1971-72	948,000	72,000	16
Forecast			
1975	1,400,000	82,000	16
1980	2,250,000	102,000	22
1985	3,500,000	117,000	30
1990	5,200,000	130,000	40

GROUNDSIDE

Automobile Parking Requirements

Total parking requirements are the result of parking demand. Separate parking areas are required for the following user groups:

Public -- air passengers and visitors

Cargo -- shippers and related visitors

Rental Cars

Taxi, Bus, and Limousine Storage

Tenants

Public

A survey of present activity indicates that a total of 1,228 on airport spaces are currently used during peak demand periods. It is also estimated that the total demand for parking is probably 1,770 spaces. Future forecasts use the relationship between these figures and the peak hour originating passengers.

These forecasts need to be broken down further into short-term and long-term parking spaces. General trends indicate that 17 percent of the total public parking should be allocated as short term.

Employee Parking Requirements

Demand for employee parking is a function of different data than public parking. As the number of air passengers increase, the ratio of passengers to employees decreases. Therefore, proportionately fewer spaces will be needed in the future. Presently the airport has 300 employee spaces. The 300 spaces can accommodate 650 employees because of working shift arrangements and the trend of auto pools. The following forecasts indicated projected space requirements for employees.

Rental Parking Requirements

These forecasts are based on current conditions and adjusted to the increase in passenger numbers. This parking needs to be adjacent to the deplaning area.

Curb Parking Requirements

Determining of curb length requirements is done by analysing the passenger vehicle activity and forecasts. Curbside counts of vehicular types were taken relating to peak hour volumes. For both arriving and departing passengers, the results are graphically illustrated in the table. The highest percentage of curb usage for both departing and arriving passengers was that of private cars. Taxis and limousines made a noticable increase in demand by passengers leaving the airport.

An important point the survey also illustrates is the length of time the vehicles were parked at the curb. Eighty-five percent of the cars were at the curb for less than two minutes at the passenger drop off, while the same percentage of vehicles took an average of 2.45 seconds longer at the pickup curb. This data from the survey by Arnold Thompson and Associates resulted in the following forecasts.

TERMINAL CURB REQUIREMENTS

ENPLANING CURB

Year	Pk. Hour Enpl'g Passengers	Curb/Passenger Ratio	Curb Length
1971-72	580	0.48	280 l.f.
Forecast			
1975	850	0.46	400 l.f.
1980	1,300	0.44	600 l.f.
1985	1,900	0.42	800 l.f.
1990	2,700	0.40	1,100 l.f.

DEPLANING CURB

Year	Pk. Hour Enpl'g Passengers	Curb/Passenger Ratio	Curb Length
1971-72	510	0.43	220 l.f.
Forecast			
1975	750	0.42	300 l.f.
1980	1,100	0.41	450 l.f.
1985	1,700	0.40	700 l.f.
1990	2,300	0.38	900 l.f.

EMPLOYEE PARKING FORECAST

Year	Total Annual Passengers	Spaces Per 1,000 Total Passengers	Employee Parking Spaces
1971-72	1,896,284	0.16	300
Forecast			
1975	2,800,000	0.14	390
1980	4,500,000	0.15	675
1985	7,000,000	0.15	1,050
1990	10,400,000	0.14	1,460

RENTAL CAR PARKING REQUIREMENTS/READY LOT

Year	Terminating Passengers	Space Per 1,000 Originating Passengers	Spaces Required
1971-72	673,180	0.12	80
Forecast			
1975	950,000	0.12	115
1980	1,500,000	0.12	180
1985	2,300,000	0.12	280
1990	3,500,000	0.12	420

PUBLIC AUTOMOBILE PARKING FORECAST

Year	Originating Enplaned Passengers	Peak Daily Originating Passengers	Space/Peak Daily Originating Passengers	Number of Spaces Required
1971-72	673,180	2,300	0.77	1,770
Forecast				
1975	950,000	3,200	0.68	2,200
1980	1,500,000	4,900	0.73	3,600
1985	2,300,000	7,400	0.73	5,400
1990	3,500,000	11,000	0.73	8,000

INTERFACE REQUIREMENTS		1975	1980	1985	1990
	Airline Ticket Counter Length - lin. ft.	280	400	550	750
	Airline Ticket Counter Area - sq. ft.	5,600	8,000	11,000	15,000
	Airline Ticket Counter Offices - sq. ft.	5,600	8,000	11,000	15,000
	Airline Operations Offices - sq. ft.	16,000	22,000	30,000	40,000
	Departure Lounges - sq. ft.	32,000	44,000	60,000	80,000
	Baggage Claim - sq. ft.	15,000	24,000	32,000	40,000
	Baggage Handling - sq. ft.	33,000	50,000	62,000	70,000
	Concessions & Rentable Space - sq. ft.	25,000	40,000	49,000	55,000
	Airport & Government Offices - sq. ft.	10,500	10,000	12,000	15,000
	Public Space - Circ., Lobbies, Toilets - sq. ft.	108,000	164,000	202,000	226,000
	Mechanical Equipment - sq. ft.	--	15,000	17,000	19,000
	Total Passenger Terminal Area - sq. ft.	250,000	385,000	490,000	575,000

DEMAND / CAPACITY ANALYSIS

DEMAND/CAPACITY ANALYSIS

Existing Terminal Capacity

An inventory of the terminal building reveals the building operating at near capacity. The capacity of the existing airport is 235,000 annual operations. This is in comparison to the 1975 total of 194,832 operations. The forecasts indicate the total operations capacity will be exceeded within the next five years. The airport has planned to meet the expected growth by constructing a new runway which will increase the capacity to 397,000 after completion. Construction of the runway is essential to the future of airport growth, however, there are several important environmental issues which have resulted in litagation. Whether or not the runway benefits outweigh the costs is beyond the scope of this study. Because growth is dependent on this addition and for the purpose of simplicity, the runway shall be considered an existing facility.

Aircraft Parking

The capacity of aircraft parking indicates a serious problem. Currently the airports terminal building has 16 gates. However, projections demand indicates 22 gates will be needed by 1980. The existing building is cramped between two existing runways which restrict buildings in terms of setbacks established by the FAA. These setbacks make adding another concourse or the extention of two of the existing concourses impossible. The remaining concourse is capable of being expanded to allow only four more gates, bringing the total to 20 gates. This number is below the 1980 demands requirements.

Curb

In addition to this unresolvable problem of aircraft parking, more curb space is badly needed, yet, the only way to solve this requirement would be to eliminate some of the short term parking which is at a premium and would mean lost revenue.

Circulation Space

Still another problem is evident to anyone who enters the facility during peak hour traffic, the building is overcrowed in every respect from the tickets area to baggage claim. Boarding gate lines often run through the concourse into the lobby and out the front door. Ironicly if the same person were to observe the airport one hour later, it would seem almost barren. This is the result of airline scheduling which cannot be adjusted without creating negative delays and lay-overs for passengers.

Public Parking

A review of the parking forecasts indicate that existing facilities are not capable of handling the requirements based on existing demand. The existing demand is 1,770 spaces while the airport currently offers only 1,400 parking spaces. Obviously, more facilities are needed to handle a portion of the demand. However, there is no more surface area available for parking.

Public Access

Forecasts indicate that a larger percentage of passengers will be arriving from the west than the south by 1990. The existing site has poor access to the main western artery -- I-85 and the proposed highway loops.

Summary

The analysis indicates that the addition of the new runway satisfies the capacity requirements indicated by the projected demand and the deficiencies indicated by the demand/capacity analysis illustrates the need for a new air terminal facility.

SITE

Site Selection

The question of whether Douglas Muncipal Airport should be moved to a new site should receive early priority in the planning study. The conclusion drawn from existing studies indicates it is uneconomical to move the entire airport to another site. Possible sites have been investigated and those which seemed feasible were analysed according to topography, location, access, and surrounding land use. These investigations suggested that reproduction of the 3,000 acres necessary for the duplication of the facilities existing at Douglas Muncipal Airport is economically not feasible when compared to the alternative of expanding the existing facilities at Douglas. The studies take into account that the expansion of the existing airport will require a new terminal building.

More recently the issue of surrounding land use has raised a question to the expansion of the site. The environmental projection act of 1969 required the filing of an environmental impact study for approval by each new airport before expansion could occur. Interestingly, no major airports have been built since the act was established. Charlotte was the first airport required to file a study and feels the impact of the EPA heavily. The airport is currently fighting in court to keep its expansion plans alive. The issue is whether or not the airport will be allowed to build a new runway needed to handle the increase in air traffic. If the runway is not built, Charlotte's airport growth will be terminated and the forecasted air traffic will be shifted to neighboring airports like Greenwood or Raleigh Durham. The city depends upon its airport as has been pointed out earlier and to sever a major artery would severely cripple the growth of Charlotte. The new airport is vital to the area and therefore will be built. However, to avoid a lengthy and tedious debate, this study shall deal with the existing surrounding land use as if it were compatible with the airport, therefore, eliminating the major obstacle in the path of future expansion.

Site Characteristics Analysis

The site chosen for the new terminal building is ideally located between the proposed runway 18R-36L to the west, runway 186-36R to the east, and north of the crossing runway 5-23. The site is bounded at the north by the airport property line created by the southern railway line.

The site topography is typical of the Charlotte region and the rest of the airport in general. There is a seventy foot height variation between the lowest and the highest points on the selected site.

There are few restrictions on the site beyond topography. The runway and taxiway setbacks form the northern, western and eastern building boundaries. This along with the southern railroad property border to the south establish a total buildable area of 270 acres.

The site is heavily wooded with topped trees. A network of fire roads currently occupy the site along with a few warehouses left over from the days when the site was used for amunition storage.

MAJOR ISSUES

MAJOR ISSUES

Four Primary Issues:

Passenger Convenience

Economy

Flexibility

Safety

- Passenger Convenience: Passenger convenience is a factor of walking distances. The ideal way of handling passengers from the standpoint of their convenience would be for one to arrive at the curb, check his bags within a few steps and immediately board the plane. For this method to work it would depend upon every passenger arriving exactly at the departure time. However, from a logistics standpoint, this is impossible. It would be impractical to process all the boarders at one time. Therefore, passenger convenience is also a factor of processing times.

In addition to the processing delays, no one could estimate his travel to arrive at exactly one time. In fact, passengers begin arriving at the airport as early as two hours before the scheduled departure time.

Another factor for the convenience of passengers are amenities for the early arrival and transfer passengers. These amenities contribute to the space factors of convenience. Ramp delays which are product of scheduling and runway capacity, also effect the convenience of the passenger.

The social convenience of the passenger in terms of satisfaction received from visitors and guests is an important factor. While visitors may pose as a problem by adding to congestion, etc., they are an essential part of an air trip.

- Economy: The economy of the building is measured in terms of construction and operating cost. An important factor effecting the design from the economy standpoint reveals that each of the facilities of the terminal is used for specific amounts of time by successive users. For example, as each flight arrives, it uses the gate vacated by another plane. The flight's passengers should use the same baggage facility which was used by the previous flight. Some of the facilities can be shared by different flight groups at the same time; such as ticket sales and baggage claim areas.

Economy is a function of how much sharing takes place and how efficiently it is executed. Unwanted duplication of services wastes capital and adds to the operating costs of the building. A factor inconsistent with economy is the current practice of exclusive area use. This is the practice of the airlines using separate facilities to maintain an individual image. The planning for the terminal facilities must reflect the practice of exclusive area use.

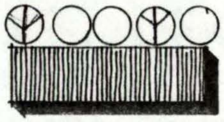
● Flexibility: Maximum flexibility of the terminal to accommodate change is the goal of the design. Maximum flexibility means maximum efficiency of space. Flexibility is also a factor of phasing. Construction cannot occur at the rate of passenger growth or it would never stop. Therefore, the building must be able to be built in steps. Flexibility is also a factor of the actual development as compared to the forecasts which the building was designed to meet. Forecasts are highly susceptible to change and many never materialize. This can be very costly in terms of efficiency for a building which is inflexible.

To accommodate the flexibility required to cope with change, one must insure independence of the three basic elements of the passenger terminal; The airside, the terminal building and the landside. Change of one faculty in one of these elements should be allowed without effecting the other elements. If for example, as technology increases, more passengers are handled per plane than was designed for, the support facilities inside the terminal need to be able to increase without a change in the number of gates, because more people will be arriving on the same number of planes.

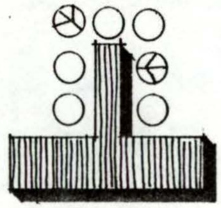
- Safety: Safety is an important consideration in any public building. However, in light of the skyjackings of the recent past, air terminal safety in the form of security deserves special consideration in the design. Provisions must be made to accommodate a security program. Location of this facility can be critical. In the Dallas/Fort Worth Airport security was not considered, the result was a guard at each boarding gate. This tremendous increase in operating expenses illustrates the importance of this issue.

TERMINAL CONFIGURATIONS

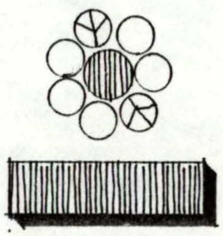
TRADITIONAL TERMINAL CONFIGURATIONS



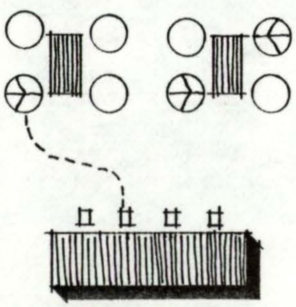
LINEAR



PIER



SATELLITE



TRANSPORTER

After stating the function of the building and the describing of major issues which need to be evaluated, the next step in air terminal planning is the description of the basic configurations available that have been developed around the airport major handling systems. Each configuration contains inherent "tradeoff" between the major issues. While none of the configurations can be expected to be perfect with respect to every issue, some configurations will maximize benefits to the user more than others. The purpose of this section is to describe the basic configuration available and evaluate each in terms of the major issues, adaptability to the site will come later.

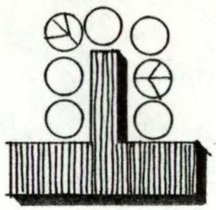
These basic configurations are the pier, satellite, linear and the transporter concepts. In addition to the basic configurations, there have been some terminals which use two or more of the configurations at the same time. The basic terminal configurations are the result of an evolutionary process that began in the early 1930's.

In this first generation the terminals were very small. All the facilities were contained in a single shell, therefore, walking distances were very short. Planes were also very small and parking space requirements for these planes were minimal by today's standards. While the configuration worked very well it was limited to the volumes it could handle as it typically was efficient for only one or two planes at one time. Today terminals of the first generation are still used for small airports.

As air traffic grew, the demand for more gates increased. The airside facilities increased in proportion to the interface. The solution to the problem was found in the second generation of terminals. In some instances additional gates were attached to the existing terminals. These gates created "fingers" which extended out from a main building. At other airports the airfield was extended to encompass the terminal creating a "ring", to achieve the air space needed to meet increased demands. Examples of the second generation are the pier and linear configurations. This era also saw the use of several first generation terminal types grouped on one site, as seen at John F. Kennedy International Airport.

The third generation of air terminals are a result of the inability of the second generation to meet the demands of the major issues. The major difference in the two types is the innovation of transporter systems, which move passengers inside and outside of the interface. Because walking distances are virtually eliminated as a problem, the building size can increase for more efficient use of terminal facilities. Examples of this generation of terminals include the satellites and transporter configurations.

SECOND GENERATION
PIER CONSTRUCTION



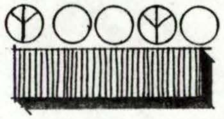
Passenger Convenience - passengers walking distances are very high resulting from indirect relationship of auto parking to the aircraft. Process areas are centralized which is good but it also tends to maximize the walking distances in this configuration.

Economy - facility sharing can be maximized and concept contains a centralized processing facility, therefore, the cost of the scheme is low.

Flexibility - Expansion is limited by the relationship of the terminal to runway because of set back requirements, also pier expansion beyond a limited point creates very high walking distances.

Examples - Chicago, O'Hare and Atlanta

LINEAR CONFIGURATION



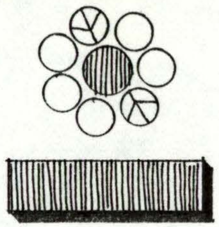
Passenger Convenience - the linear concept is an extention of the first generation type terminal. Passenger convenience is very good as auto parking is directly related to the aircraft.

Economy - there is a negative effect on cost because of duplication of processing facilities created by decentralization. The linear concept, as an extension of the small building type terminal, becomes in essence separate units housed under one roof. Building construction is rather simple,therefore, costs are reduced.

Flexibility - expansion occurs as a linear outgrowth of the terminals and can occur simply, independent of the auto/aircraft elements.

Examples - Kansas City International

THIRD GENERATION
SATELLITE CONFIGURATION



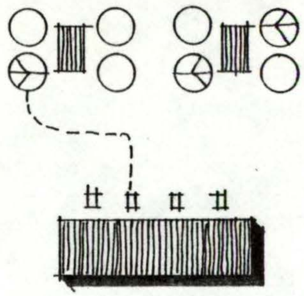
Passenger Convenience - a satellite is a small remote structure connected to the terminal building by an under ramp people mover. The people movers decrease walking distances to a minimum.

Economy - sharing of facilities achieves reduced cost, however, the initial cost of creating the underground connection is very high.

Flexibility - Satellites were introduced to improve flexibility over the pier configuration by increasing aircraft maneuverability. The result is mixed. While maneuverability is increased there is a creation of unnecessary pavement areas. Expansion is relatively easy provided land is available through careful planning. Satellite flexibility is best for square configuration rather than round or other polygonal shapes.

Examples - Houston, Newark and Tampa.

TRANSPORTER CONFIGURATION



Passenger Convenience - the basic configuration is similar to the pier concept. However, walking distances are shorter because the piers are replaced with transport vehicles which travel to the planes. High levels of convenience and comfort are offered to most passengers; however, the ever present problem of the late boarding passenger is ignored.

Economy - sharing of facilities is very high as is the general efficiency of the utilization of facilities since the transport can take the passengers almost anywhere without increasing walking distance. Construction costs are relatively low; however, maintenance and operational costs are significantly increased by the mobile lounges.

Flexibility - expansion is very easy and inexpensive to provide. The expansion of any element can occur independent of the other. Maneuverability of aircraft is at a maximum.

Example - Dulles

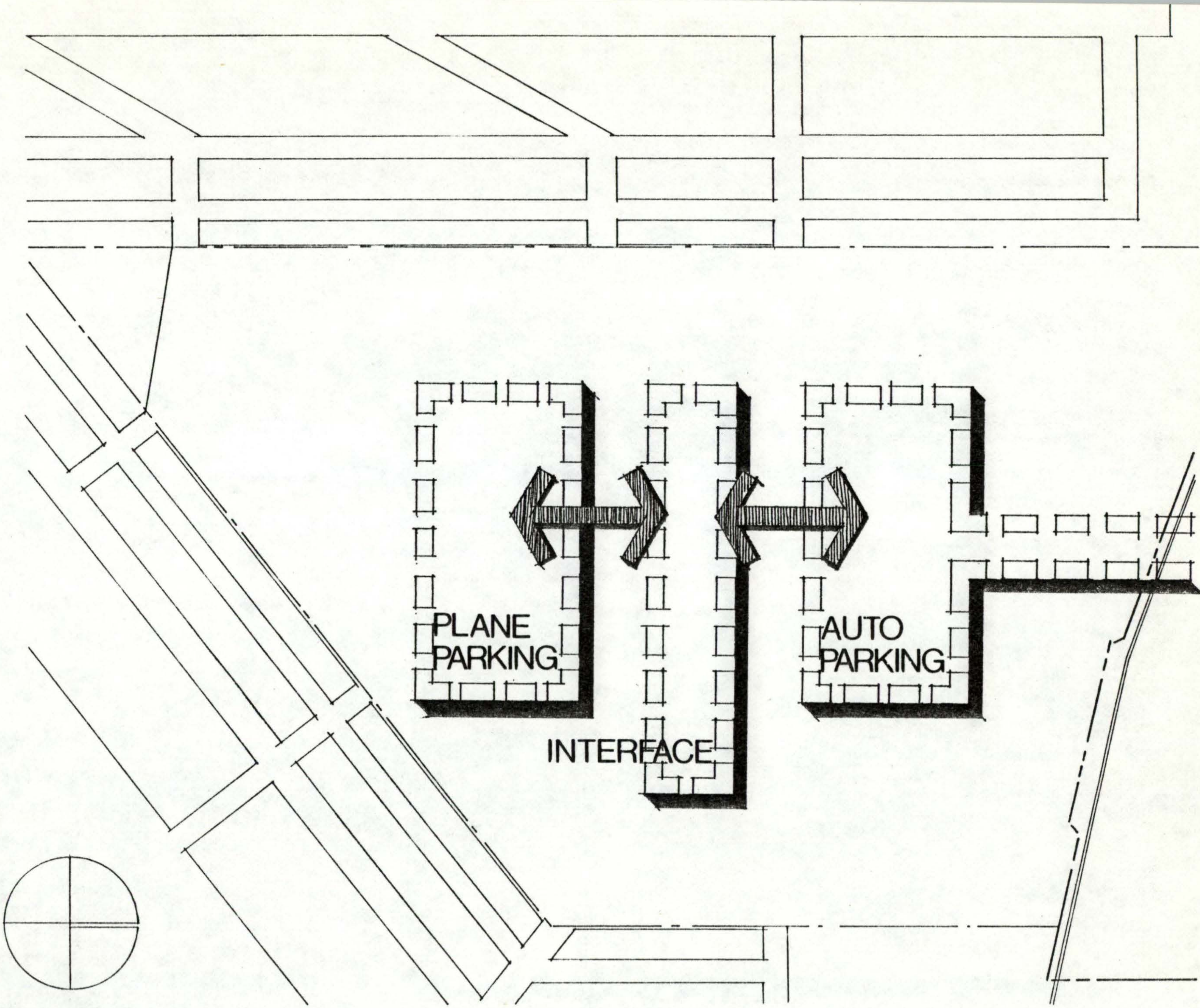
In addition to these basic configurations, combinations of these concepts have occured in an attempt to get maximum use of the site. Example of a few combinations are seen in the illustration. Other concepts such as off site terminals are now being initiated but are not relevant to Charlotte.

CONCEPTS

SITE CONCEPT

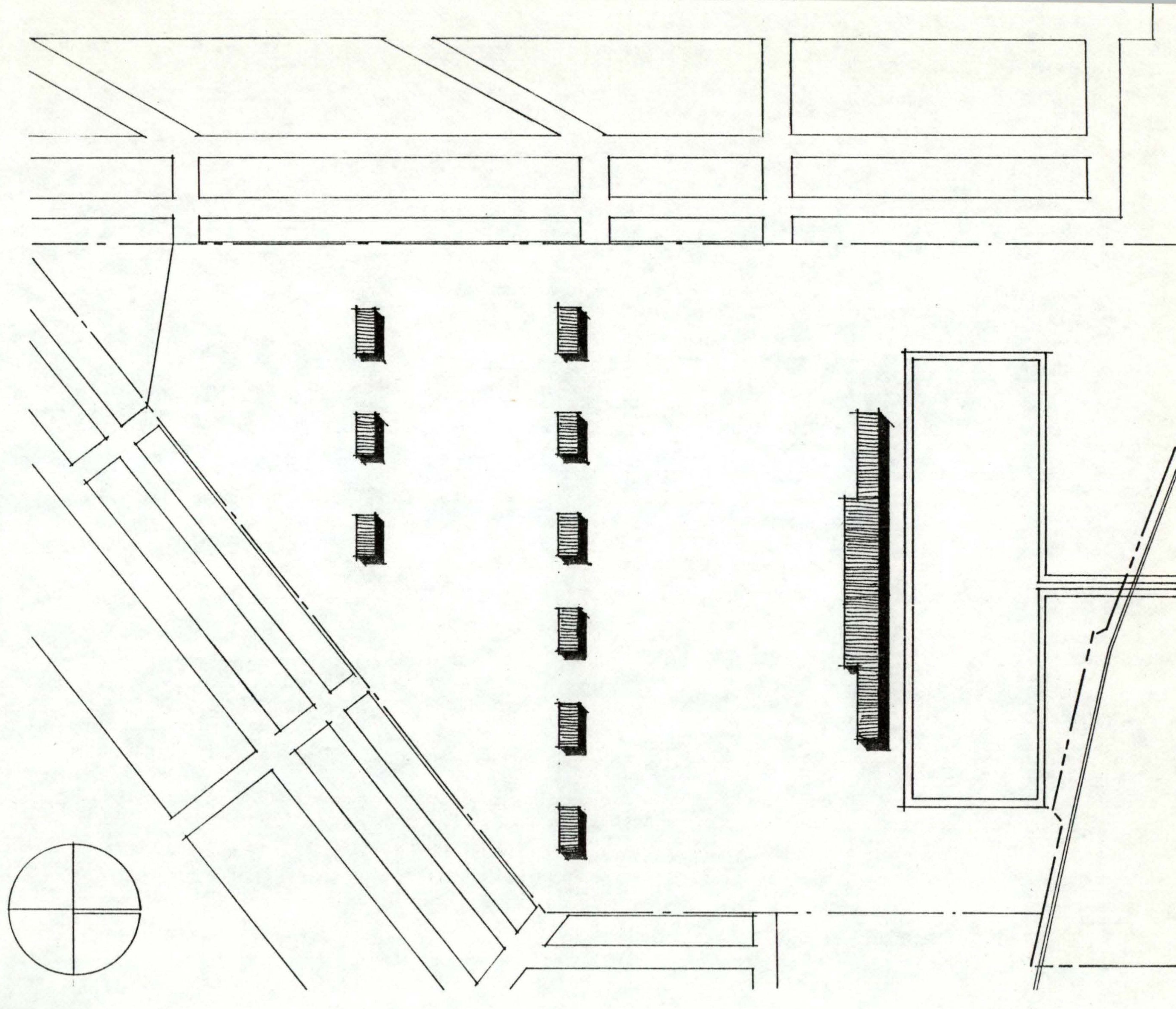
The site concept for the airport involves providing a vehicular access from the major traffic to the north directly to the airport in a manner similar to that used at Greenville-Spartanburg jetport. The cars will loop around and return to the major traffic arteries from which they came. The area inside the loop will be used for public parking.

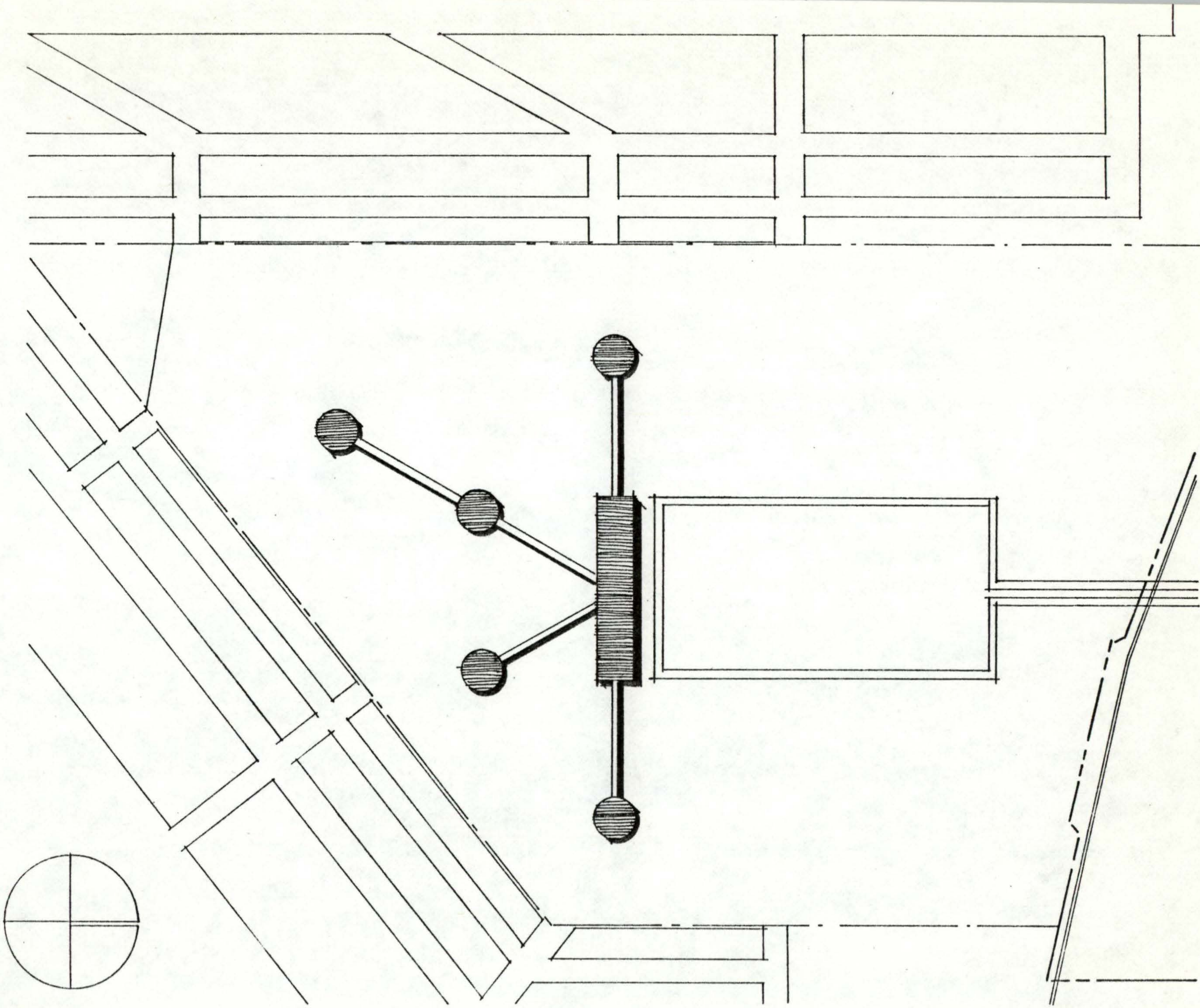
Aircraft access comes toward the loop from the runways. Separating the two transportation access system is the interface or terminal building.


PLANE
PARKING
INTERFACE
AUTO
PARKING

Refinement of the concept comes when the major issue of flexibility in terms of future expansion is considered. The result is a very linear building which can be added to as dictated by demand, without sacrificing the integrity of the building form.

While the initial site concept was being refined, the traditional configurations were applied to the site and analyzed. The two which were considered as having the best characteristics for Charlotte were the transporter type, and the satellite type. Both could easily be adapted to the site, however because of high operating costs and the inconvenience to late arriving passengers, who are generally businessmen and make up the largest percentage of passengers, the satellite configuration was adopted. Admittedly, this type of concept has a duplication of facilities but this uneconomical inherent fault is discounted by the fact that the airlines policy is consistent with this separation of facilities. Therefore, each pod can be assigned to a different airline for their exclusive use. In the case of smaller airlines, a pod might be shared while some of the support facilities could still be used exclusively by the individual air carrier.





BUILDING CONCEPT

The interface is a vital circulation system of the city which houses two major circulation systems. While studying the relationship of the interface to the site and the transportation systems of the city, one must also examine the internal systems of the interface itself. The terminal is made up of two major circulation systems: passenger movement and baggage movement; and minor circulation systems of visitor movement and transfer passenger movement. Examining these major circulation systems one can see the functions which are common to baggage and passengers. Both come from the curb and go to ticketing where they separate. Both come separately from the plane and unite at the baggage claim area and then to another curb, or an alternative link to the external transportation system. It is important to note that while the function of ticketing and baggage claim are shared they have no direct relationship to one another. This is important because when one also considers the issue of passenger convenience measured this time in terms of "people" congestion, the concept of isolating these two facilities by housing them in separate buildings seems ideal as it separates the flow of internal movement thus minimizing congestion without sacrificing function.

The refinement of the concept reveals two double loaded corridored buildings radiating from a central focal point, thus forming two "rings". Ticketing functions are housed on the outside corridor of the interior "ring", while the interior load of the ring is the enplaning curb.

The structural systems available include the pie shape one-way system and the spiral two-way system. The two-way system was used as it shortens the effective span length by equalizing the spans. The beams will be deep span concrete left exposed. The mechanical system will use an air plenum above the beams, as will the electric and communications systems. Separate air handles will condition the building in zones. They will be located in the towers on the interior sides of each ring.

PRESENTATION

PRESENTATION OUTLINE

I intend to submit my comprehensive study to Dean McClure and the Faculty of the College of Architecture for review using the following outline as a guide for my oral presentation.

I. Statement of Intent

II. Slide Presentation

Slide 1: Graph, illustrating airlines historical dominence in the travel industry

Slide 2: Future trends - 76% increase by 1985

Slide 3: Map of county, showing relationship to C.B.D. and traffic network

Slide 4: Map of county, traffic forecasts, major growth in north and west

Slide 5: Airport boundries map with new site/existing facilities relationship. Discuss advantages

Slide 6: Land use map as proposed by county planners

Slide 7: Aerial of new site, with runways, railroad and I-85

Slide 8: Topography map of site

Slide 9: Initial concept superimposed on site

Slide 10: Diagram of traditional terminal configuration types. Identify types and major issues of design

Slide 11: (A) Dulles International: Transporter configuration. Discuss advantages and disadvantages with respect to major issues.

Slide 11: (B) Interior of Dulles. Discuss influences on design

Slide 12: Model of Kansas City International: Linear type configuration. Discuss advantages and disadvantages with respect to major issues.

Slide 13: Houston International satellite configuration. Discuss advantages and disadvantages with respect to major issues and types of satellite pods used.

Slide 14: (A) Bönn Airport - illustrates more articulated pod type -- limits, flexibility

Slide 14: (B) Interior of pod - influences on design -- 1. Concrete waffle pan system, 2. Lighting

Slide 15: Transporter configuration superimposed on site: using major site concept

Slide 16: Pier configuration applied to site using major site concept

Slide 17: Pier configuration illustrating refinement of design

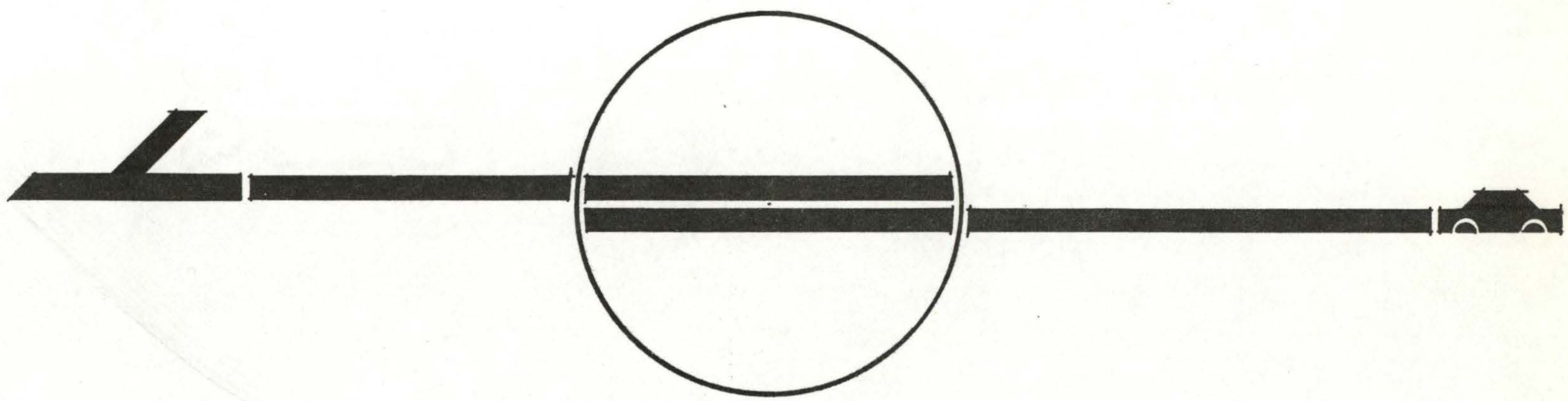
Slide 18: Refined concept superimposed on site

Slide 19: Satellite configuration refined and imposed on site

Slide 20: Building concept: illustrating reasoning behind separation of baggage and ticketing functions

III. Presentation Drawing

1. Walk Faculty through the building
2. Discuss systems
3. Ask for questions



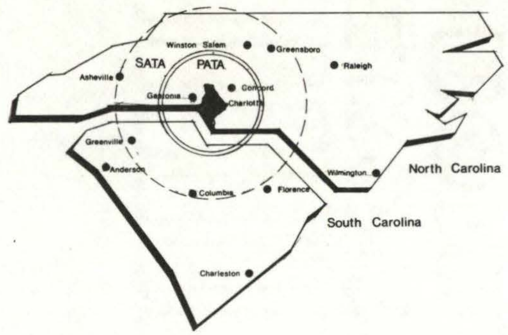
Air Terminal Complex

Douglas Municipal Airport

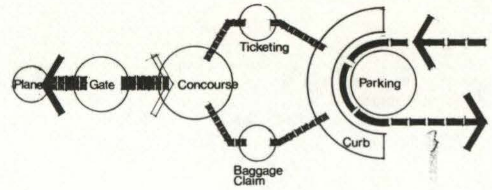
Terminal Project Submitted By Michael Patrick Keeshen

Charlotte, North Carolina

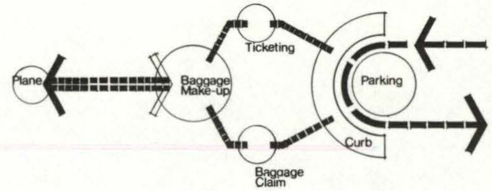
Fall Semester 1977



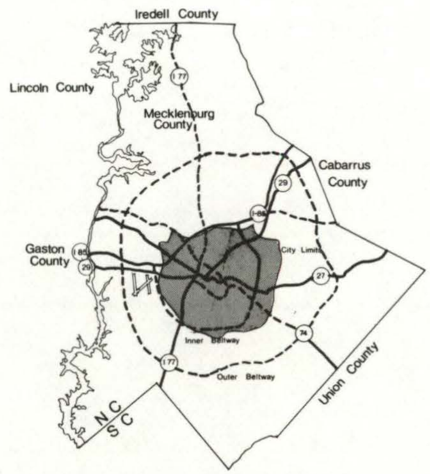
State Locator



Passenger Movement

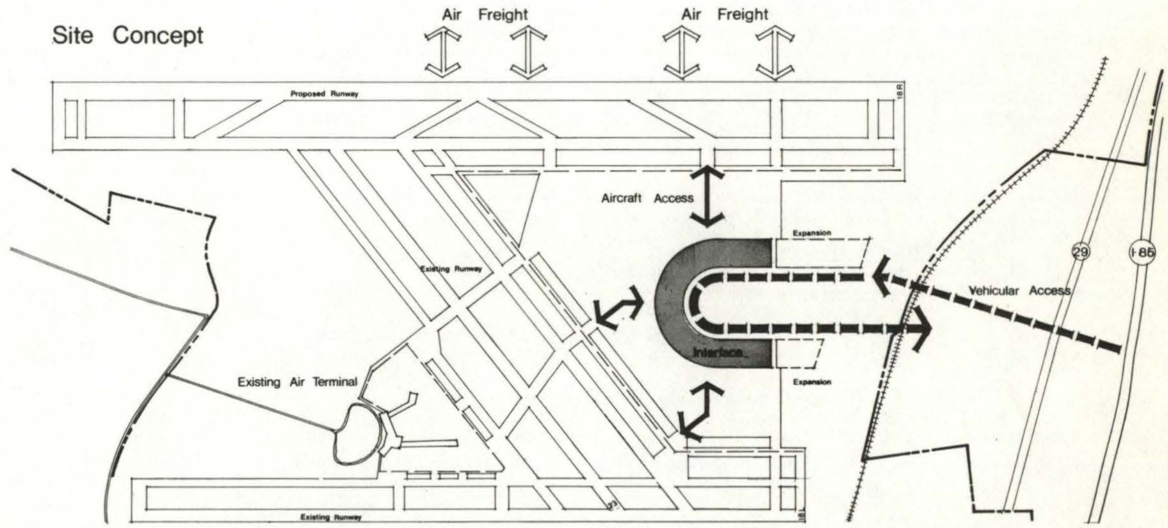


Baggage Movement



Regional Locator

Site Concept



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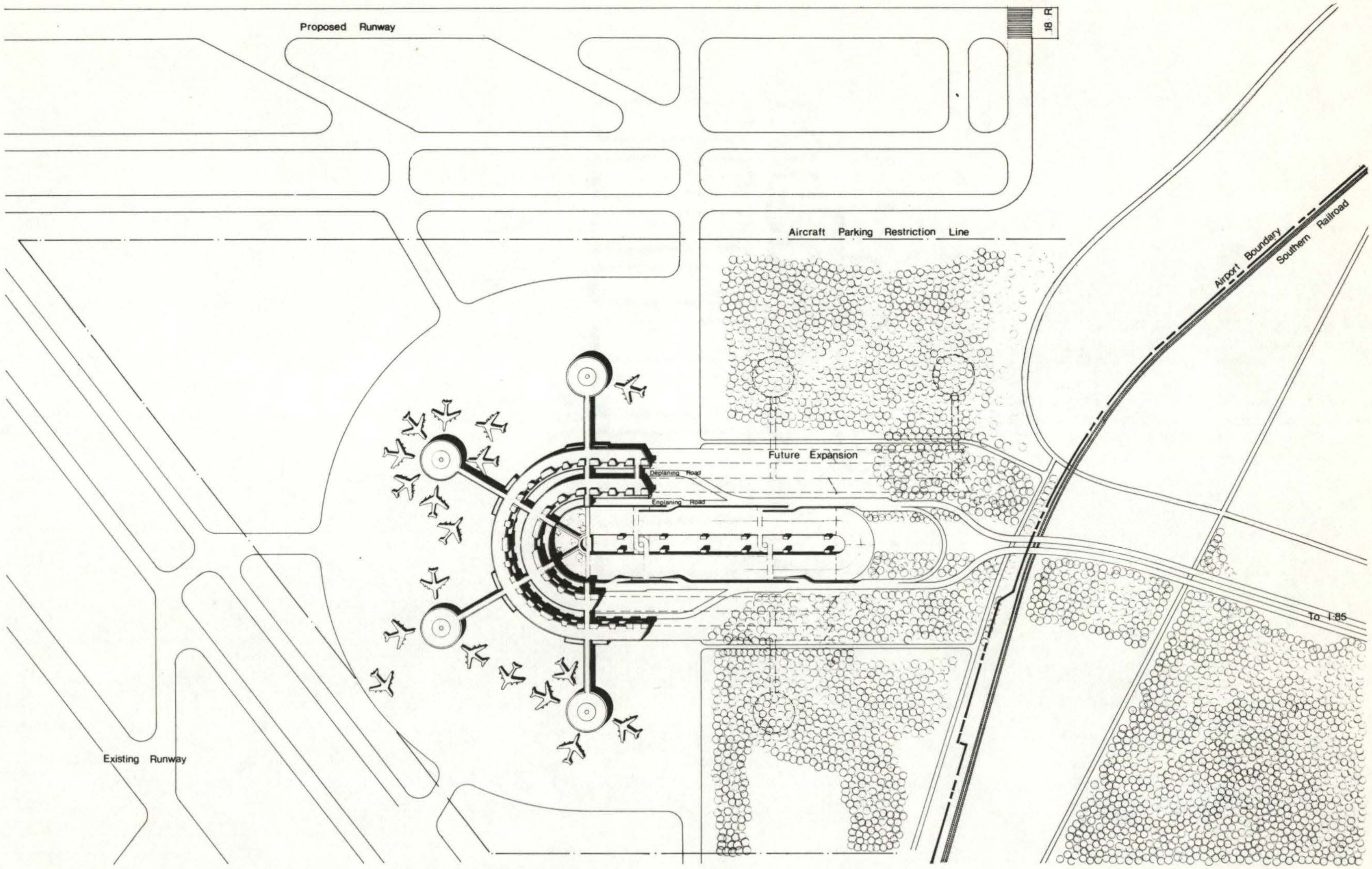
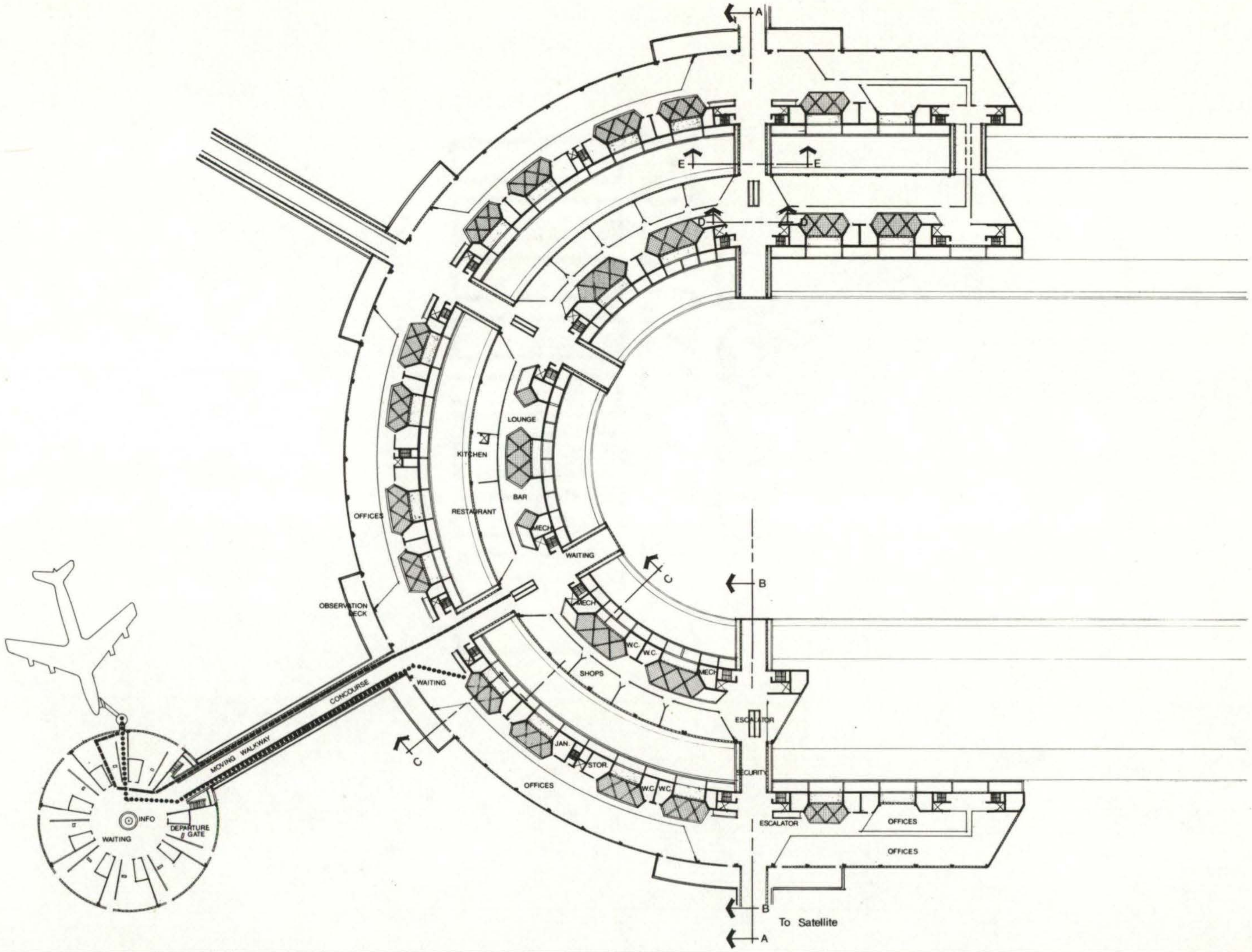

Proposed Runway
18 R
Aircraft Parking Restriction Line
Airport Boundary
Southern Railroad
Future Expansion
Deplaning Road
Enplaning Road
To I-85
Existing Runway

Site Plan

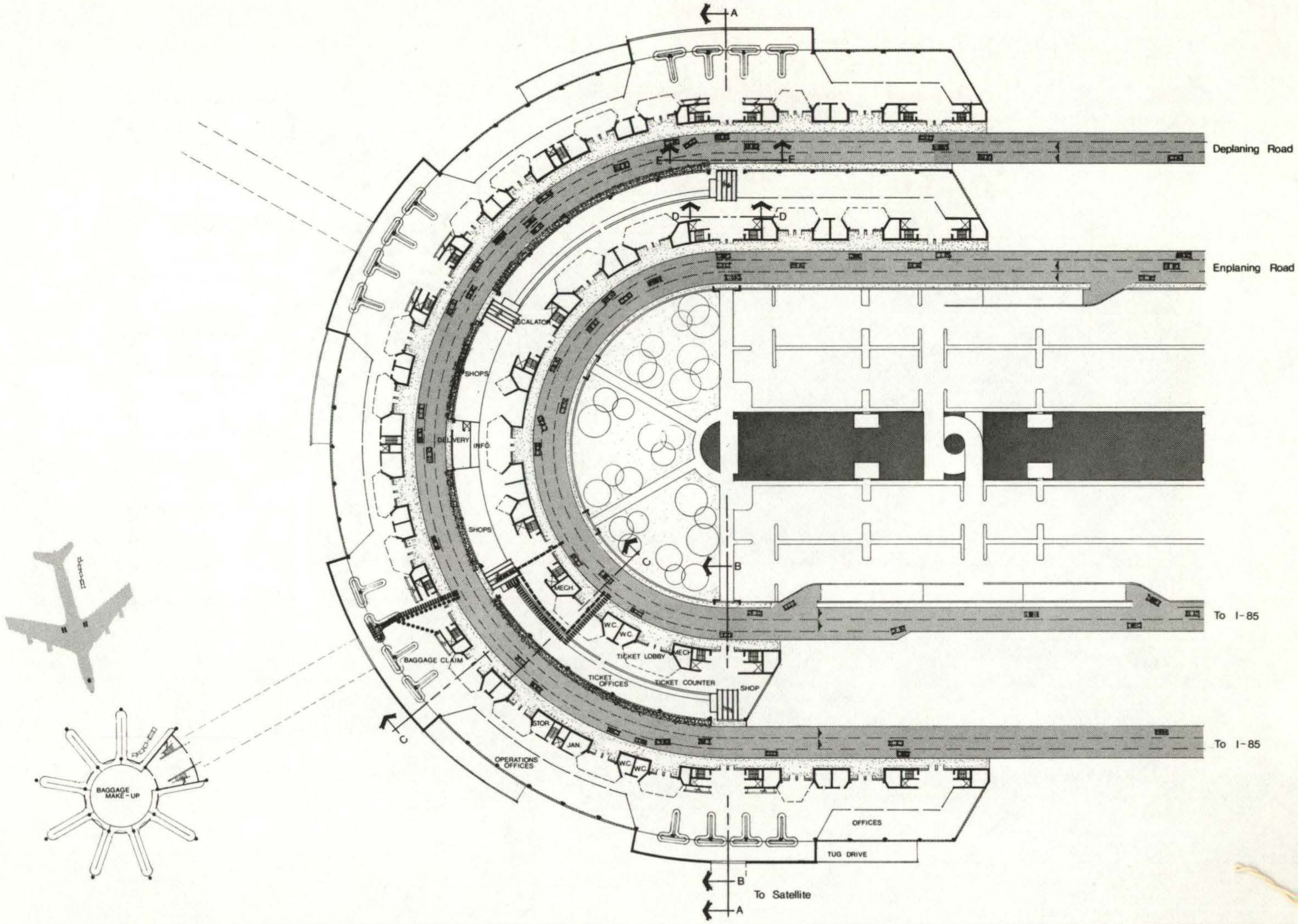
0 25 50 100 300



Upper Level Enplaning and Deplaning

Enplaning Passenger Circulation
Deplaning Passenger Circulation

0 10 20 50 100



Main Level Ticketing and Baggage Claim

Enplaning Passenger Circulation
Deplaning Passenger Circulation
Baggage Circulation

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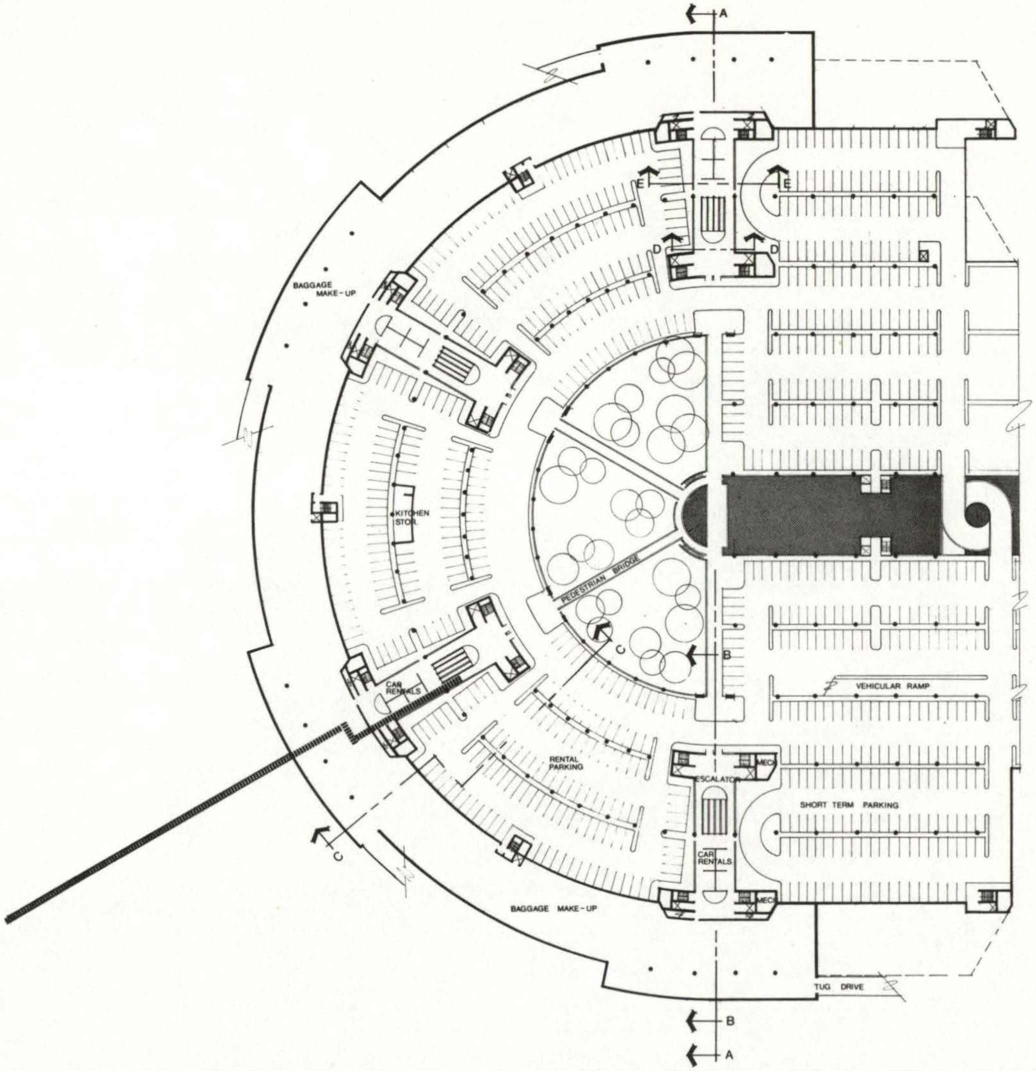

Ground Level Parking

Baggage Circulation

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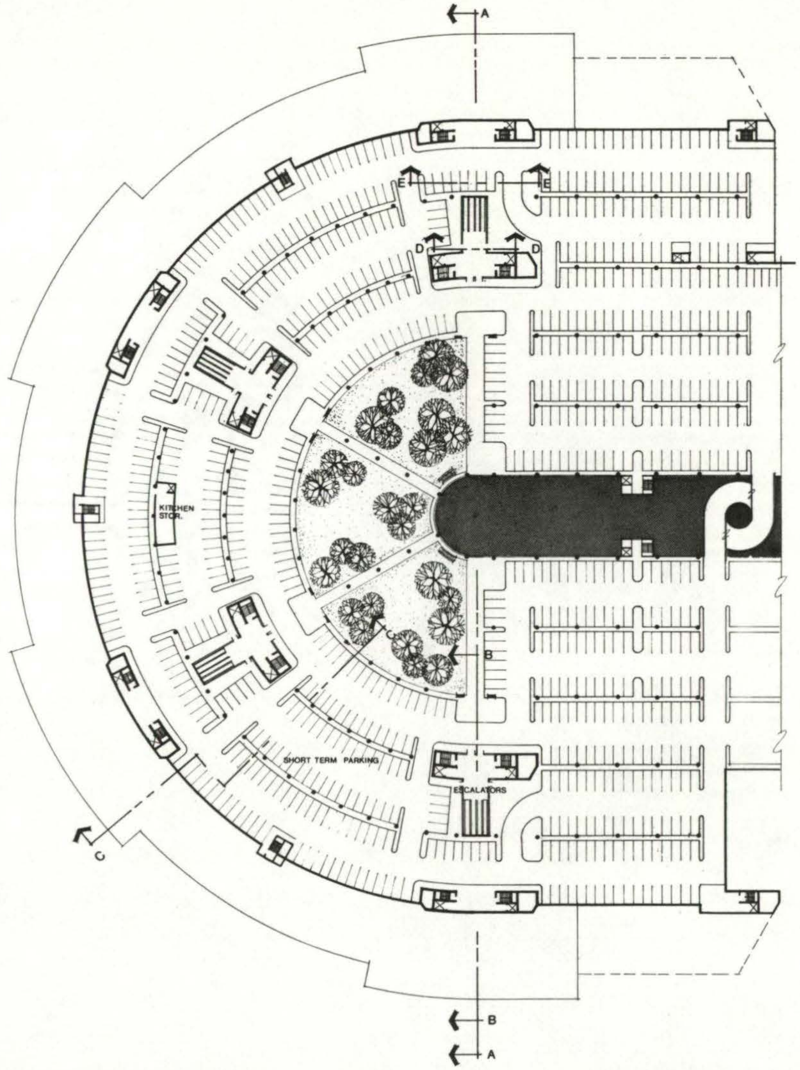
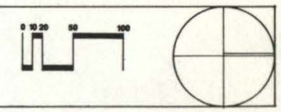
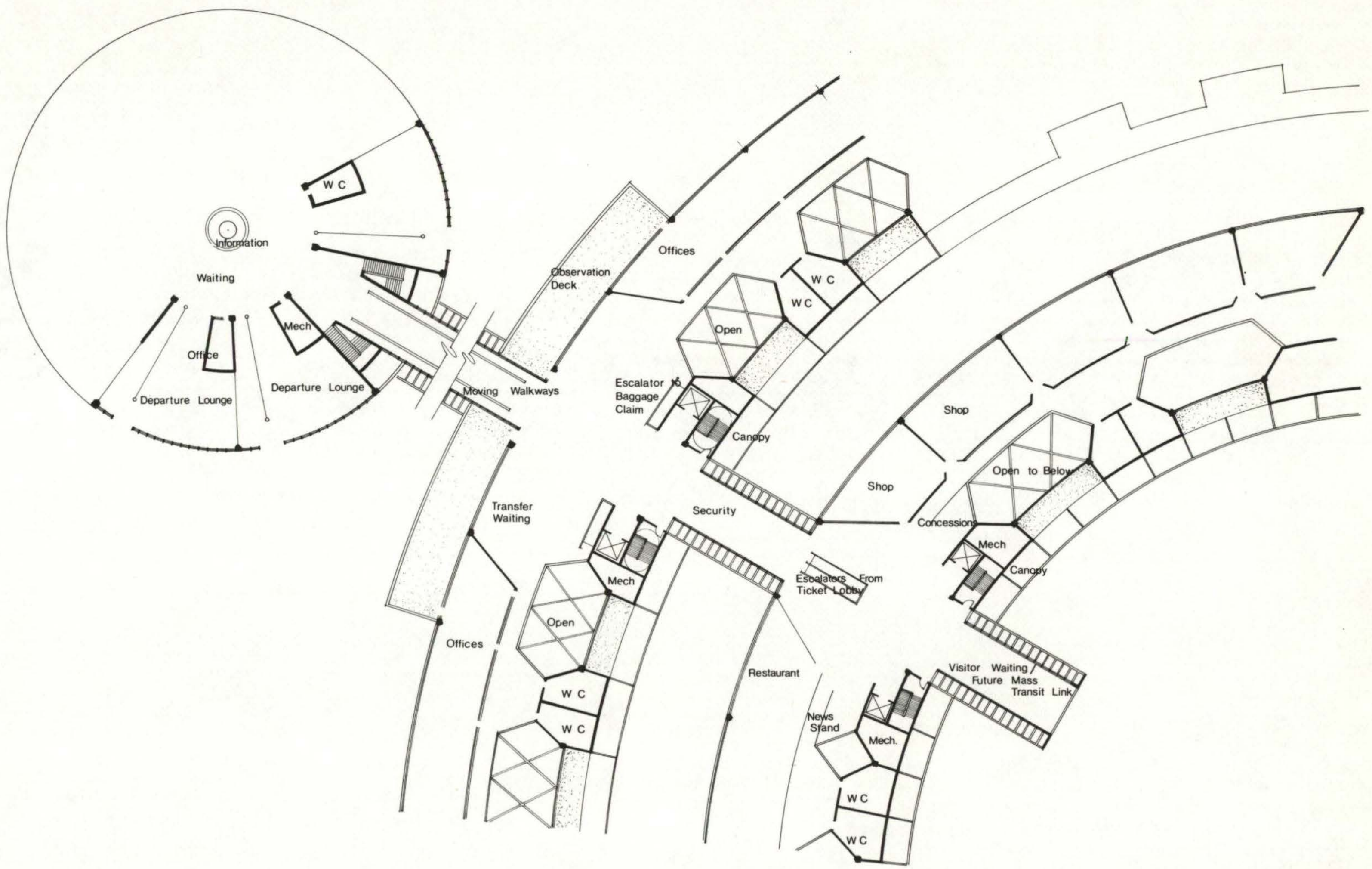
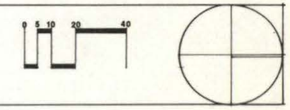


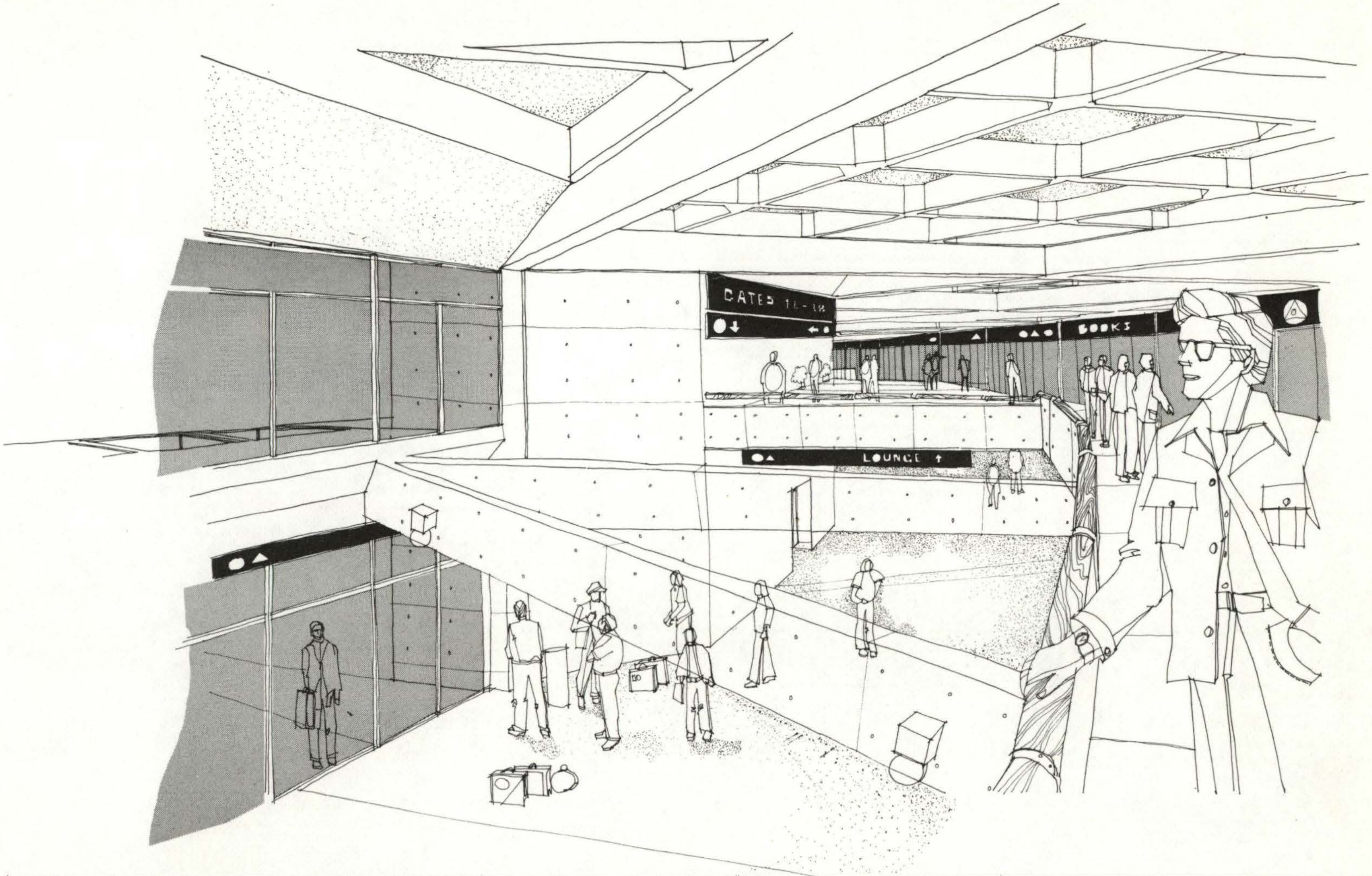
Basement Level Parking



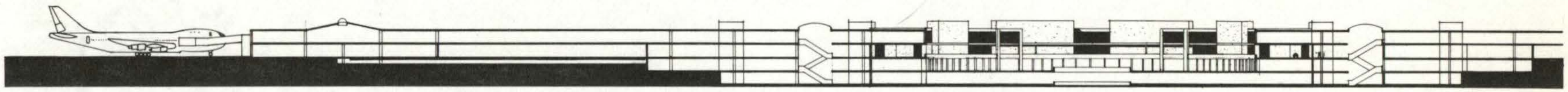


Partial Floor Plan Upper Level





Ticket Lobby



Section A–A

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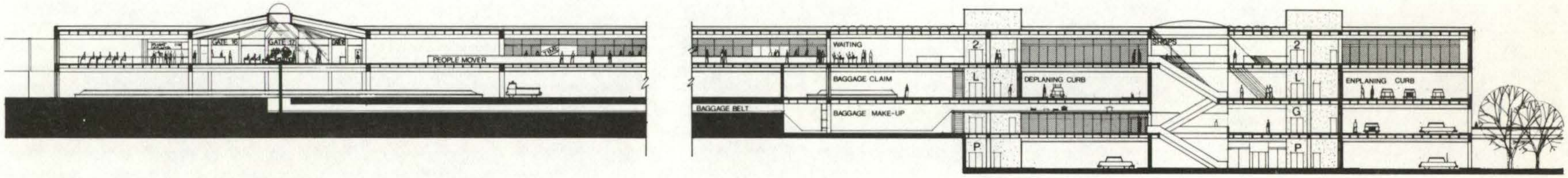

Section B–B

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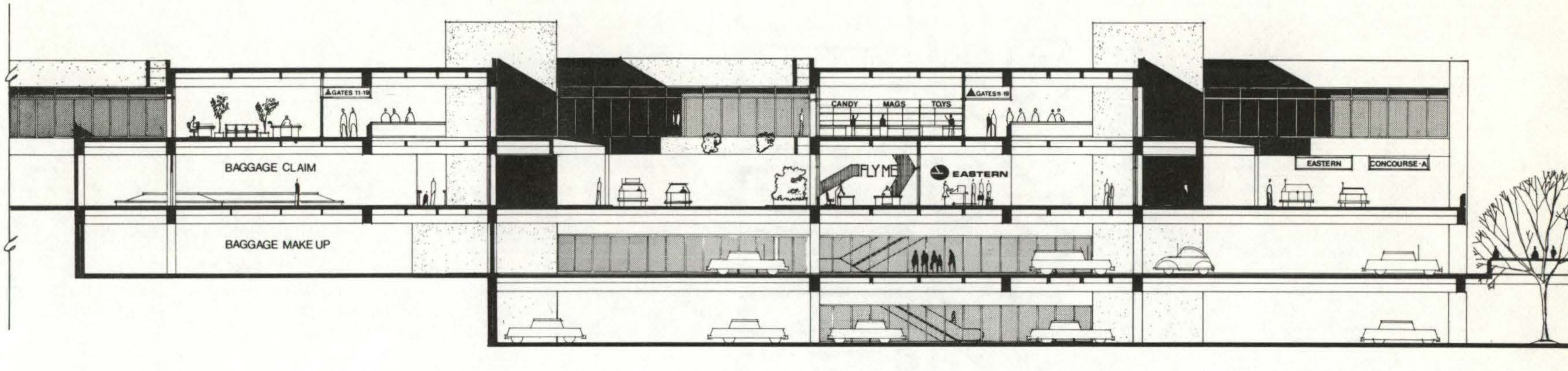
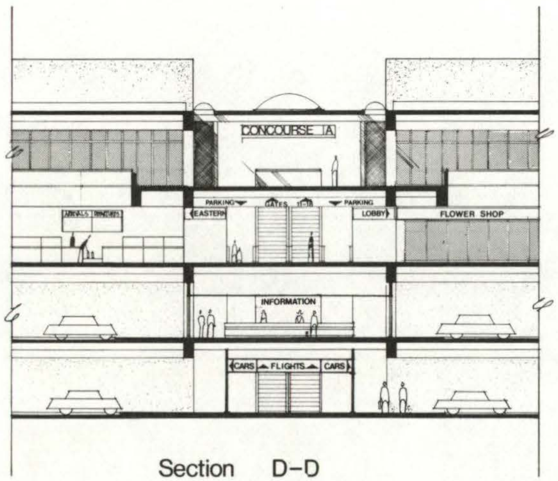
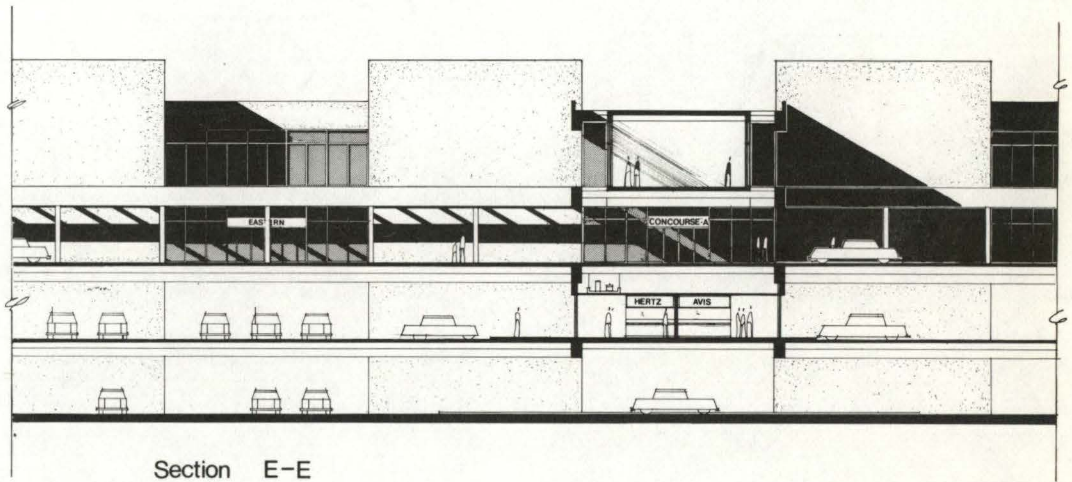
Sections



Section C–C

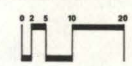


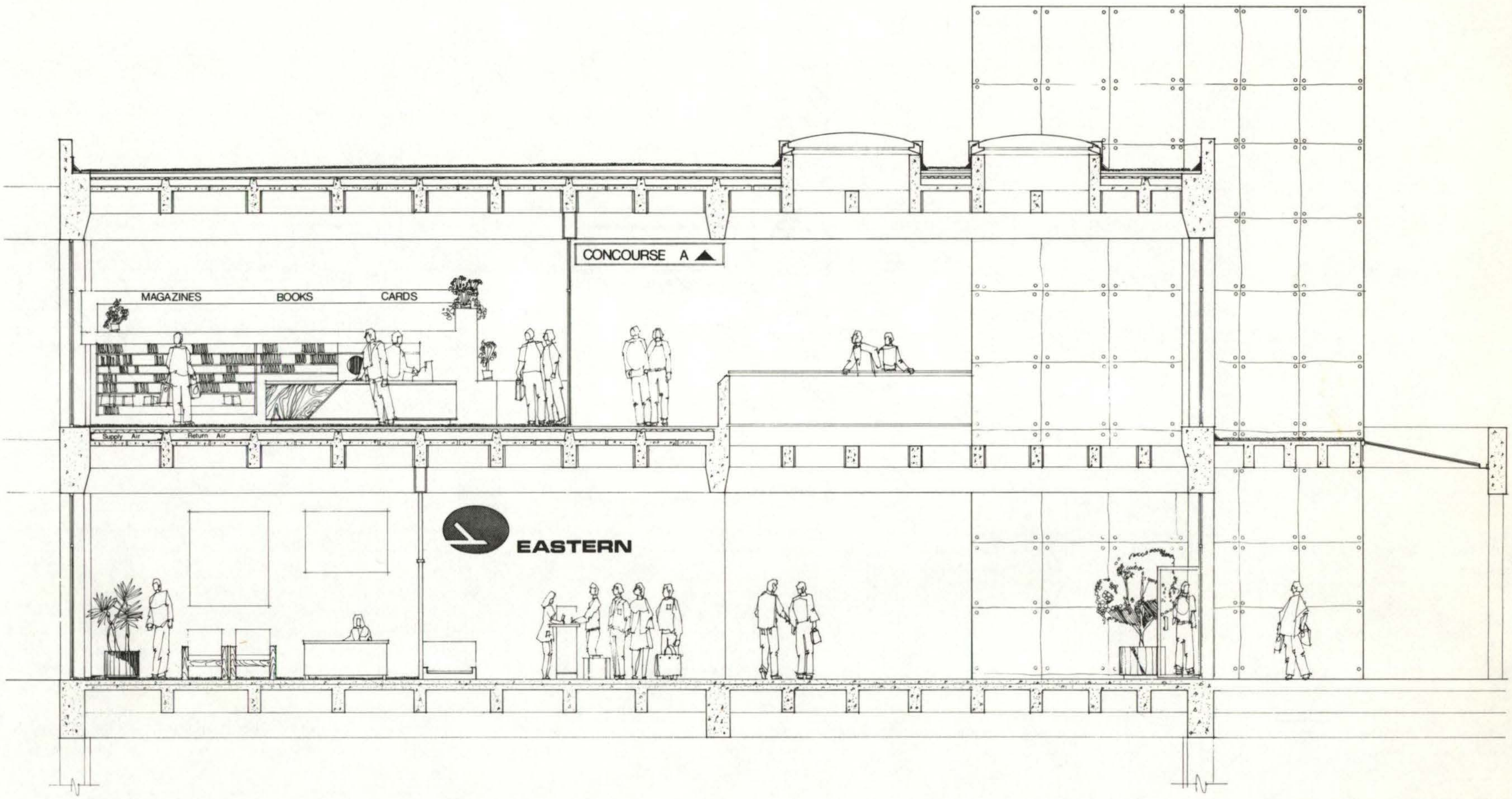
Section D–D



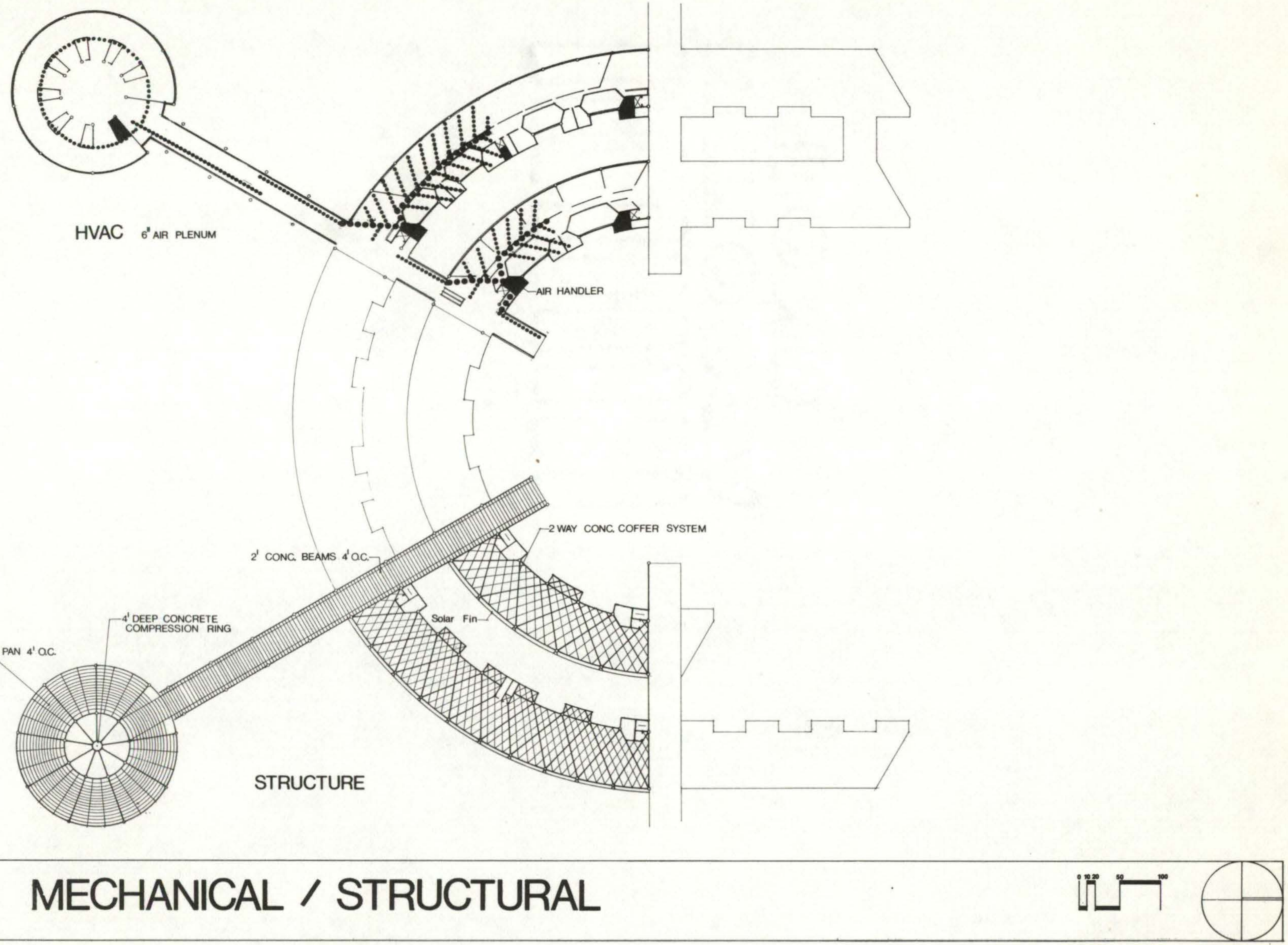
Section E–E

Sections





Structural Section Ticket Area



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